Nutritional deficiency levels of zinc and copper in aquatic invertebrates

Burt Shephard to: helleb 11/03/2008 05:25 PM
Cc: johnt, Eric Blischke, Joe Goulet, rgensemer, deforest

Helle,

I recommend setting floors for toxicity data of zinc in aquatic invertebrates of 20 mg/kg whole body wet weight. Copper requires a more complex answer. For crustaceans and molluscs, a 5 mg/kg whole body wet weight copper floor is needed. For the remaining invertebrate taxa, the 2.2 mg/kg floor used for fish copper requirements can be used. The above values are based on the nutritional requirements of aquatic invertebrates outlined below.

The literature on nutritional deficiency/sufficiency of copper and zinc to aquatic invertebrates is largely limited to studies on crustaceans. Rainbow (2007) has summarized much of the work on marine invertebrates. Several studies on Daphnia also exist. The most recent study with zinc requirements of Daphnia magna (Lam and Wang 2008) gives a sufficiency residue of 20 mg/kg wet, with a deficiency residue of about 11 mg/kg. An older study (Muyssen and Janssen 2002) of nutritional zinc deficiency in D. magna give a deficiency range of 17.4 - 29.6 mg/kg wet. The mean of these two deficiency studies is roughly 20 mg/kg wet, which will be used as the floor below which zinc toxicity studies of invertebrates will not be used during TRV derivation.

Copper is a little trickier, since some invertebrate taxa, particularly molluscs and crustaceans, contain hemocyanin, a copper-based respiratory pigment instead of hemoglobin. Thus, when added to the requirement of copper for other copper containing enzymes, the copper requirement of some molluscs and crustaceans is higher than that of other invertebrates. The Rainbow 2007 study cited earlier summarizes his work since the 1980s on copper and zinc requirements of crustaceans, and can be used to obtain a copper requirement of 5 - 7 mg/kg whole body wet weight copper. This seems to be supported by a study by Lee and Shiau (2002) on a common marine aquaculture species, the tiger prawn (Penaeus monodon), whose respiratory pigment is hemocyanin (a Google search on hemocyanin Penaeus monodon pulls up multiple studies documenting this). In P. monodon, copper deficiency is seen at 7.27 mg/kg, sufficiency from 7.5 - 9 mg/kg Cu. Several studies on Daphnia magna (Lam and Wang 2008, Bossuyt and Janssen 2003) which has hemoglobin, not the copper containing hemocyanin, show copper deficiency between 0.16 - 1.1 mg/kg, copper sufficiency at 2.0 - 14 mg/kg. For non-hemocyanin containing invertebrates, the copper deficiency and low end of the sufficiency range appears comparable to that of fish.

Note that if the original citation gave residues in dry weight, I assumed 80% water content to convert to wet weight concentrations, unless the actual moisture content was empirically measured, in which case I used the empirical conversion factor.

Best regards,

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"If your experiment needs statistics to analyze the results, then you ought to have done a better

experiment"

- Ernest Rutherford